Technology Opportunity

Glenn Research Center • Cleveland • Ohio

Technology Transfer & Partnership Office

TOP3–00195

Modeling and Analysis of Electrokinetic Forcing of Particle and Droplet Bearing Microfluidic Flow

Technology

A code has been developed for the qualitive analysis and simulation of electrokinetic effects in two-phase fluids.

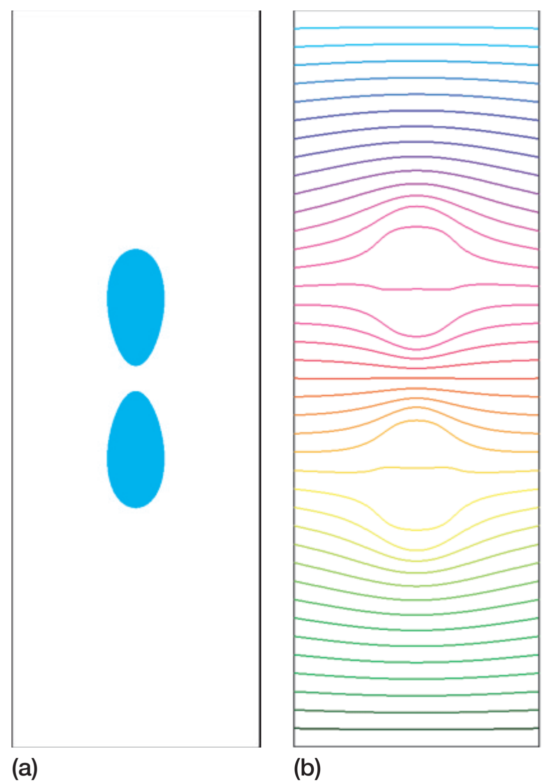

Figure 1.—Dielectrophoretic interaction of two droplets. An imposed electrical field polarizes the droplets, causing a dipole-dipole interaction between them. The drops have a higher dielectric constant than the surrounding fluid, and the field is attenuated in the drops. The drops are attracted toward each other and to regions of high electrical fields. Consequently, the two drops move towards each other and coalesce. Electrical fields are sometimes used in industry to de-emulsify two-phase mixtures. (a) Droplets. (b) Electrical field.

Benefits

The electrokinetic forcing of single-phase fluids

- Is programmable
- Scales well with reduction in device size
- Can be used to drive relatively nonmixing plug flow

This work seeks to find out how, and if, these benefits can be extended to inhomogeneous flows. Electrokinetic effects can also be directly useful for two-phase liquid-liquid mixtures by providing a way to change surface tensions and wall-wetting properties. Surface tension can be greatly reduced through electric effects, providing a means to mix immiscible fluids and to form micro- and submicron-scale emulsions. The ability to change wall-wetting properties may provide a new way to harness and control capillary forces in MEMS devices.

Commercial Applications

This work seeks to aid in the understanding and application of electro-osmotic and electrophoretic forcing of fluids to such applications as the analysis of blood, microelectromechanical systems (MEMS) cytometry, separation of particles from fluids, transport of insoluble fluids, and electrokinetic separation of interdispersed insoluble fluids.

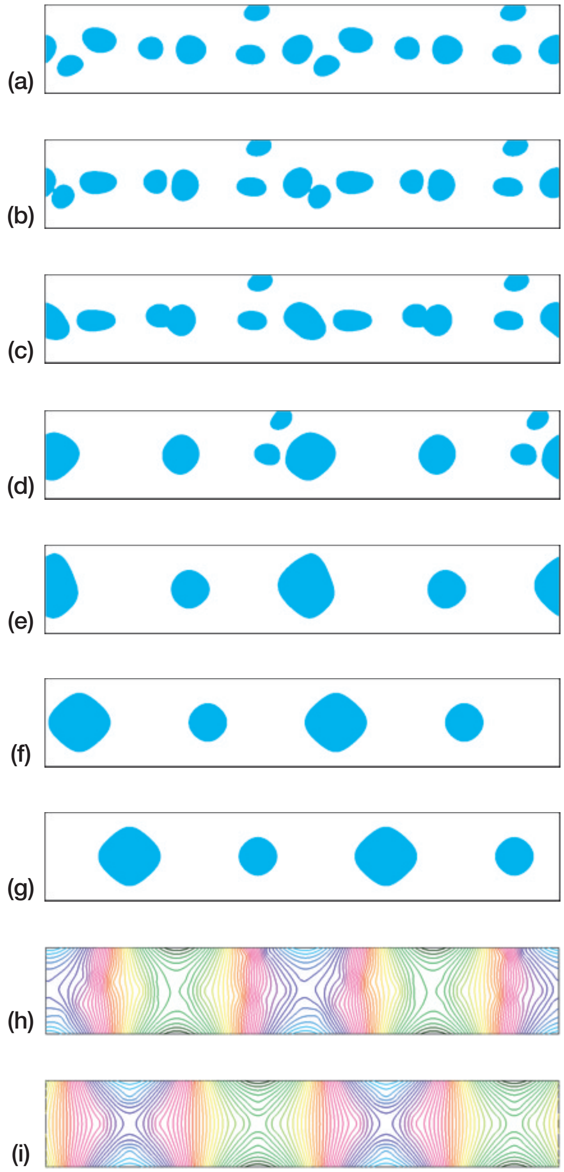

Figure 1.—Traveling-wave dielectrophoresis. The flow is driven by a sinusoidal traveling electric field with a 400-V amplitude. The channel is 100 µm wide. Because the drops have a lower dielectric constant than the surrounding fluid, they are attracted to regions of lower electrical intensity. At first (parts (a) to (d)), "de-emulsification" processes are dominant. The resulting larger drops then become trapped in low-intensity regions and are swept to the right by the traveling electrical wave. The wave and drops move at a rate of 3 cm/sec. Part (h) shows the electrical field corresponding to part (a), and part (i) corresponds to part (g).

Technology Description

A code has been developed for the qualitative analysis and simulation of electrokinetic effects in two-phase fluids—including electro-osmosis, electrophoresis, dielectrophoresis, and traveling-wave dielectrophoresis. A parallel experimental effort is being started. The figures show two computational results. Figure 1 shows an example of the dielectrophoretic interaction of two droplets, and Figure 2 shows traveling-wave dielectrophoresis.

Options for Commercialization

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References

Key Words

Electrokinetics
MEMS